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Article

Research on the Sustainability of the Enterprise Business Ecosystem from the Perspective of Boundary: The China Case

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Abstract: In the context of the Internet, the business environment shows great uncertainty. This kind of uncertainty has not only changed the original competitive boundary of enterprise completely, but also the competition rules of enterprise. The cooperation of enterprises with suppliers, producers, sellers, customers, other organizations and stakeholders is getting closer and closer. The competition among enterprises is no longer the competition between individual enterprises, but based on the co-evolution under the business ecosystem. Therefore, how to create a good business ecosystem and sustainable development is the main problem faced by enterprises. This paper conducts an exploratory case study on the sustainability of the business ecosystem of enterprises from the perspective of boundary, to provide a new theoretical basis for the sustainable development of enterprises. This study investigates the specific impact of various system elements on the sustainable development of enterprises, summarizes the theoretical model, and finally provides feasible suggestions on promoting the sustainable development of the business ecosystem from the perspective of boundary.

Keywords: boundary; sustainable; ecosystem; case study

1. Introduction

The 21st century is a time of rapid economic development, when humans face various crises such as the shortage of resources, ecological imbalance. How to achieve the strategic goal of sustainable development, the sustainable competitive advantage and sustainable development has become a practical problem facing all enterprises. The sustainable development of enterprises is not simply to prolong the life cycle of enterprises indefinitely, but also continuously in the selected fields. Based on this, Moore puts forward a new strategic theory: business ecosystem. He proposes that companies should have “ecosystems and organisms in biological”, and “think of yourself as a part of the business ecosystem organism”, therefore, the enterprise competition turns into the competition of business ecosystem, and business ecosystem sustainability becomes the main problem that enterprise needs to solve.

In the context of the development of the business ecosystem, the boundary of the enterprise is gradually blurred. The spanning and reconfiguration of enterprise boundaries affect the stability of the business ecosystem. The spanning of enterprise boundary is a complex process, especially when the rebuilding or promoting of the existing business ecosystem is involved. This requires enterprises to have an overall perspective to not only handle the boundaries between industries and industries, but also between internal organizations, so to help enterprises to successfully span the boundary and realize the sustainability of the business ecosystem. Traditional theories hold

that boundary spanning has a significant impact on the sustainability of the business ecosystem, but its effectiveness in explaining the practical problems of enterprises in the Internet environment is significantly reduced. There are three points that need to be improved: (1) From the perspective of research content, existing empirical data show that although boundary spanning can be used as an important method for enterprises to promote the development of business ecosystem, researchers mainly demonstrate at the level of theoretical reasoning, which lacks strong empirical data. A large number of case data are needed to prove the successful implementation of cross-border enterprises. (2) Regarding the research object, it is difficult to get first-hand internal management information, so specific enterprise research is missing. This directly leads to difficulty in providing operational suggestions for similar enterprises; (3) In terms of research methods, there is a lack of literature using case studies to discuss the sustainability of enterprise boundary spanning to the business ecosystem, especially discussions on the formation process and mechanism of boundary spanning.

Based on this, this study contributed to existing research in three aspects. Firstly, this paper supplements the theory of the sustainable development of the business ecosystem from the perspective of boundary spanning. Secondly, this paper uses the case study method to describe the development process of the business ecosystem in detail through a large number of investigations and first-hand information, which is one of the few research paradigms. Thirdly, a boundary-spanning model with variable factors is proposed, which will provide us with important value in the practice and theory of business ecological sustainability in the future.

This paper is divided into several parts. Section 2 gives a literature review on the sustainability and boundary spanning theories of business ecosystem. Case study methodology, data selection, and data analysis are discussed in Section 3. In addition, the case study and model building are reported in Section 4. In Section 5, we reach the conclusions, and analyze the contributions, implications, and limitations of the article.

To summarize, based on the boundary perspective, this research takes DR (DongRunhuanneng) enterprise as the case object to discuss the influential factors of boundary on the business ecosystem. This not only has important theoretical value for opening the black box of enterprise boundary spanning, but also practical significance for Chinese enterprises to reasonably use the boundary spanning method to obtain sustainable competitive advantage.

2. Literature Review

2.1. Ecosystem and Sustainability

An ecosystem is a unified energy and material circulation, which exists between enterprises [1]. Moore (1993) first proposed the “business ecosystem” and revealed the evolution theory of enterprise ecosystem. He believed that enterprises, suppliers, producers and other stakeholders constitute the business ecosystem [2]. The business ecosystem involves two aspects. First, the enterprise needs to build the business ecosystem to realize the continuous updating and iteration of products to meet the increasing requirements of consumers. The second is that the business ecosystem will experience a loop of creation, expansion, and extinction [2]. On the one hand, based on the product development process, researchers divided the ecosystem into three communities: research, development and application, as shown in Table 1. Among them, the research community refers to the discovery of knowledge through the judgment of market prospects. The development community is the combination of knowledge and production to complete production and delivery; the application community needs to spread the new technology and complete the implementation of the product. On the other hand, the main body in the ecosystem reveals its structure and positioning mode [3]. Other scholars believe that the business ecosystem should include core enterprises, upstream suppliers, customers and downstream complementary parties. Through a series of complementary and cooperative subjects, the competitive relationship is transformed into a win-win model, even giving up the profit opportunity to help other enterprises survive, so as to achieve common growth [4].

Table 1. Four stages of business ecosystem development.

	First Stage	Second Stage	Third Stage	Fourth Stage
Ways	develop	expand	leadership	self-renewal or extinction
Core	value creation	forms the core group	authority	improvement and innovation
Strategy	<ul style="list-style-type: none"> * new technologies and methods * effective * investment * business alliances 	<ul style="list-style-type: none"> * CRM * identify and control the new market * strengthen the relationship between subsystems 	<ul style="list-style-type: none"> * improve investment Resources * centralized management and configuration * keep strong innovation ability 	<ul style="list-style-type: none"> * Precision evaluation system * determine the value of the system * improve the orbit coordinate system and the relationship between social value

Data source: The author collated according to the literature.

As for the sustainability of business ecology, researchers mainly discuss sustainable development from the perspectives of resources, structure, ability, knowledge and enterprise ecology, such as industrial analysis theory, core energy theory, resource theory, enterprise culture theory and innovation theory. The common pursuit of these theories is the sustainable development of enterprises [5]. However, most of them only focus on the analysis of single factor of enterprise growth, ignoring that enterprise growth is the result of multi-factor integration and systematic synergy [6]. Therefore, such defects will affect the explanatory ability of relevant theories. As an enterprise is an artificial complex system composed of human, material, financial, information, time and other elements, the sustainable development of the enterprise requires a systematic, diverse and dynamic composite research method [7]. Based on defining the concepts of business ecosystem and enterprise life cycle, this research summarizes the essence of enterprise sustainable development and defines its concept [8].

2.2. Boundary Spanning Theory

The “Boundary” comes from the geographical concept and refers to the boundary between countries [9]. Boundary spanning is the penetration and breakthrough between different property systems [10]. When it comes to management, in order to adapt to the change of internal and external environments, the enterprise takes some actions to create sustainable competitiveness that involve important external stakeholders including the collection of export-oriented activities, such as change management needs, project scope, get key resources, etc. The whole process generally refers to enterprise border spanning [11]. Research on boundary-spanning at the enterprise level has been extensively studied in management literature for more than 40 years. It is believed that “enterprise boundary” can be divided into four types: vertical boundary, horizontal boundary, external boundary and geographic boundary [12]. The so-called vertical boundary is mainly reflected in the hierarchy within the organization; horizontal boundaries exist between different functional departments, product lines or project teams of an organization; the external boundary is the boundary between the organization and the external environment, such as suppliers, customers, government management agencies and communities [11]. This boundary is quite distinct in the traditional organization, which makes some organizations form an internal and external relationship with the external environment. Geographic boundaries generally exist in transnational and trans-regional organizations with complex structures. Boundary-spanning theory includes a series of elements such as transboundary person, trans-boundary carrier, trans-boundary power and trans-boundary capability. These key elements are mutually adapted to enterprises’ trans-boundary behaviors under different scenarios.

The Boundary Spanner is the main body that promotes the boundary spanning. The Boundary Spanner may be a group or an individual, who is responsible for collecting or transmitting different information within the organization. In this process, the boundary spanner is formed naturally or passively [13]. The ability and cognition of boundary spanners have an important influence on the cross-border effect [14]. Earlier studies focused on the behavior of individual boundary striders, and studied the implementation of the role of boundary striders and the skills they needed [15]. In the process of individual boundary spanning, boundary object is also involved. The boundary spanners carry appropriate media to realize boundary spanning activities to some extent. The carrier can also be understood as the object that is used to promote the crossing, such as newspapers,

actual drawings, the company mail system, and other common physical objects or information systems [16]. IT tools can be effective boundary spanning vehicles that provide an information bridge for communication [17]. The successful spanning of organizational boundaries requires the co-evolution of IT capabilities [18]. In the era of the Internet, social tools have also become an important carrier for boundary spanning [17]. Boundary crossers need to establish a cooperative relationship with external stakeholders through a carrier, which is the boundary spanning mechanism. The establishment of a boundary spanning mechanism is an important way to coordinate and develop an enterprise cooperation model [19].

To allow the dimensional differences between boundary spanning strategies at the individual level and those at the organize level, the concept of boundary spanning potential has also been introduced. This potential is the sum of the skills of individuals who cross borders. Skills of boundary spanning can be divided into technical skills and communication skills [18]. At the same time, some scholars believe that the matching of boundary spanning potential and boundary spanning strategy is an important factor to determine the effect of boundary spanning. The composition of the capability includes not only the transboundary, but also other elements, such as the carrier and the power. Adopting different forms of boundary spanning is more effective for the realization of strategy, and it can help enterprises to continuously carry out system innovation along the development arc [20].

The research on the sustainability and boundary spanning of commercial ecosystem have provided abundant inspiration and reference for this paper. However, there are still three points to be explored:

First, the existing boundary spanning practice of enterprises shows that the practice of boundary spanning plays an increasingly important role in constructing competitive advantages and realizing sustainable development of enterprises. On one hand, the previous boundary theory is based on the traditional boundary division with the enterprise as the center. On the other hand, the research on boundary activities focuses on static and internal analysis, ignoring the impact of external environment on enterprise boundaries, which makes it more difficult for boundary theory to explain how enterprises use boundary spanning to maintain the competitive advantage of the business ecosystem in the Internet environment. Therefore, in the theoretical research of boundary spanning, it is urgent to conduct in-depth research on the boundary spanning theory according to the existing market environment and internal and external factors.

Secondly, the existing literature on business ecosystem sustainability mostly focuses on the discussion of concepts and related ideas, but lacks the perspective of boundary spanning to discuss how enterprises promote the dynamic construction process of self-centered business ecosystem. The application of the Internet has overturned the previous division of labor and the logic of enterprise value creation, which makes the single research business ecosystem less rigorous. Therefore, it is necessary to introduce a new perspective, namely the theory of boundary spanning, to study the sustainability of enterprise business ecosystem in the new environment.

To sum up, in view of the rapid changes of the situation and the lack of theoretical research, it is expected that this paper will make some breakthroughs in the existing research limitations, so as to provide reference for the practical development of enterprises. Therefore, this paper combines the theories of boundary spanning and business ecosystem sustainability and selects a successful enterprise case in China—DR—as the research object to open the “black box” of how enterprises construct and maintain the sustainable development of the business ecosystem in the Internet environment.

3. Research Methodology

3.1. Method and Case Selection

In this paper, we choose the exploratory case study method for three reasons. First, the research core of this paper is how to realize the sustainable development of business ecology through boundary spanning. The exploratory case study approach is suitable to this topic. Second, in the development

process of China in recent years, many typical and representative enterprises have achieved the sustainable business ecosystem through boundary spanning behaviors. However, China's research scenario involves more complex phenomena, so it is more suitable to use the method of a case study. Third, the existing academic research on the boundary problems of enterprises in the construction and development of the business ecosystem is still limited and at the exploratory stage. Exploratory case studies are particularly suitable for this type of research.

There are three main reasons for choosing DR as the case sample. Firstly, it takes the principle of importance and representativeness into consideration [17]. The case object DR has certain brand influence and popularity in the industry, and the business ecosystem is highly representative, which can represent the development direction of the industry. Secondly, the selection follows the principle of theoretical sampling. The research context has changed, and the existing literature has defects on the interactive process of how boundary spanning promotes the sustainable development of enterprises. Based on the perspective of boundary spanning, this paper studies the "black box" process of enterprises using boundary spanning to promote the business ecosystem, which contributes to the sustainability and boundary spanning theories. Finally, the case selection gives consideration to the suitability principle of theoretical objective and case object. In the Internet era, the case enterprise is faced with difficulties and challenges. DR promotes the development of the business ecosystem through a series of actions spanning the boundary.

3.2. Data Collection and Analysis

The data collection of the case enterprises used in this paper began in 2019, and the investigation lasted for more than 6 months. Including theory extraction, data collection, data analysis and data verification, the final determination of the theoretical framework.

Firstly, before the formal investigation, we will have a preliminary understanding of the target enterprise through the acquisition of external resources and make an interview outline. Sources of external resources include the company's official website, online documentation, news and articles. The collection of secondary data provides a basis for our field investigation; Next, we find out the theoretical framework that can be studied through the typical characteristics of enterprises and combined with management theories, and preliminarily determine the relevant theories of business ecosystem sustainability and boundary spanning. After these two tasks, we began to develop a structured interview outline, and the research team was divided into six groups to conduct research on the target enterprises through interviews, observe and verified.

Secondly, we conducted a field survey of the target enterprises. The survey included 15 managers, including the production manager, research and development manager, human resources director and operations director, who were responsible for the cube. People are selected as research objects for the following reasons: Firstly, they are employees who have deep understanding of the company's current situation and future and can describe the company's behavior and the comparison before and after development more objectively. Secondly, they are all stakeholders of the research objectives. They are highly involved in project proposal, research and development, product and use, and can involve substantive issues. Finally, there are 15 respondents in this survey; the main purpose is to achieve triangulation verification, so that the data we get will be more objective. To ensure the validity of the data, the research team raised open questions based on sustainability strategies and boundary-spanning methods, and recorded the whole process. The field investigation lasted 5 days, and the number of transcribed words reached nearly 1.5 million. At the same time, in order to make the data content more objective, we adopted the form of anonymity in the survey and interview to ensure that more real data could be obtained.

Finally, after our investigation, we obtained some information from the company, such as meeting summary, research reports and some specific product data descriptions. From these materials, the research results are triangulated to form our official research data. These data combine internal, external, industry and government data, so our data are more objective, accurate and convincing.

3.3. Data Coding

The process of data analysis and data coding in this study mainly includes the following steps:

First, open coding. In this stage, first-order concepts are formed mainly through the words repeatedly mentioned by interviewees. After the formal interview, the interview recordings are sorted into documents and repeated reading, so as to objectively grasp the purpose of the interviewees' expression and avoid imposing the existing theoretical framework on the interview data.

Second, spindle coding. In this stage, the boundary spanning and relevant theories of the business ecosystem are compared repeatedly with the interview data to summarize the second-order concept. This stage is the key stage of theory and innovation.

Third, selective coding. The focus of this phase is to examine the second-order concepts and examine all the coded data to form a summary concept.

Therefore, based on the above coding analysis, it is summarized as Figure 1.

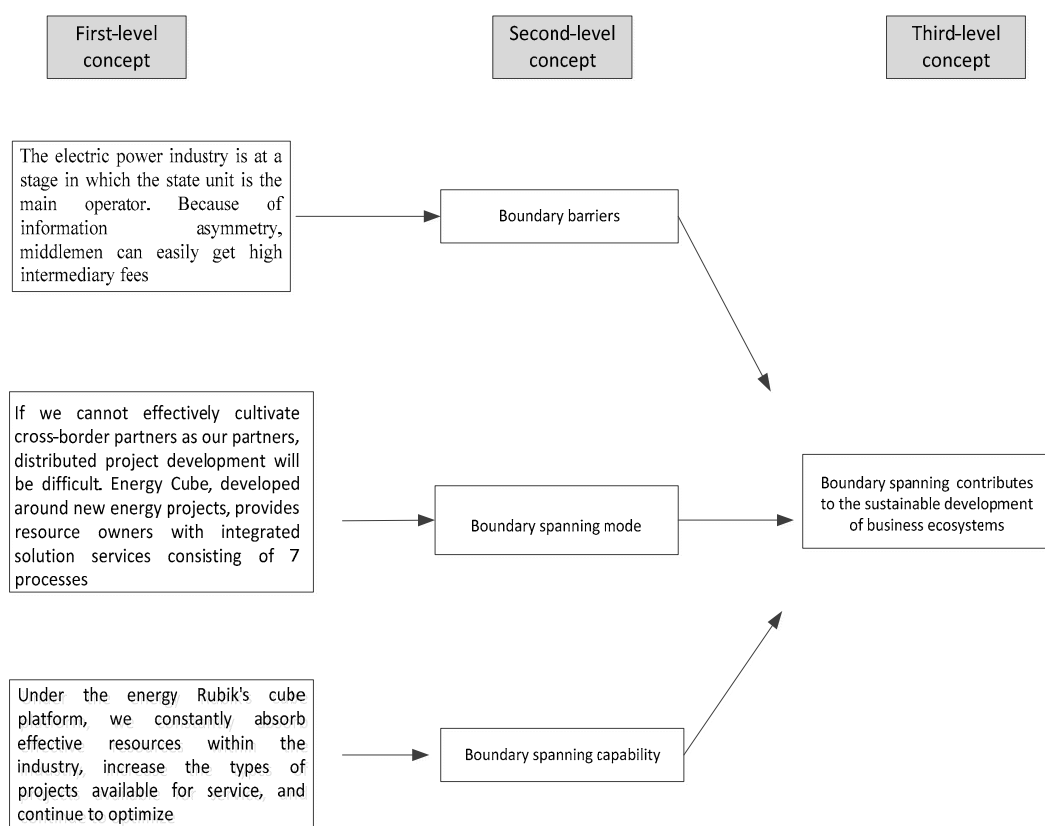


Figure 1. Hierarchical diagram of concepts.

4. Case Description and Analysis

4.1. Case Background

Founded in 2009, DR Technology Co., LTD. (DR) is a service company that focuses on the field of new energy power, integrating government consulting planning, investment and the development of new energy projects, engineering implementation, grid-connected products and green industrial finance. Up to now, the company has provided wind power/photovoltaic power prediction products and services for more than 1000 projects of dozens of main new energy groups such as Huaneng; to provide new energy grid connection dispatch products and services for provinces, prefectures and counties of State Grid and China Southern Grid. In 2009, after the promulgation of the Notice on Improving the on-grid Tariff Policy for Wind Power Generation, wind power industry emerged, and the company paid attention to this new direction and carried out the wind power business.

With the gradual maturity of the wind power industry, the company has grown into a well-known domestic online and offline business as an Internet platform.

Under the guidance of national policies, DR continuously develops a new energy forecasting and sharing platform. Through the integration of all aspects of the industry, the new energy Internet platform “Energy Rubik’s Cube” was developed. In 2014, DR was listed on the New Third Board, transforming from a manufacturing enterprise to a new energy Internet platform. Its main business is a data information service of new energy electricity. In 2020, DR’s operating income reached 94,871,900 yuan, up 14.14 percent year on year. As a leading enterprise in the industry, how DR achieves the sustainable development of its business ecosystem deserves our study.

4.2. Identify Boundary Barriers of the Sustainable Development of Business Ecosystems

In the first stage, the core business of DR is prediction system products. A single type of product gradually loses the competitive advantage. Therefore, the enterprise needs to build a new business ecosystem centered on core products to realize its sustainable competitive advantage. However, in the process of building a business ecosystem, boundary problems from professional technology, service management and other aspects are encountered. Firstly, the biggest obstacle is in the transition from traditional manufacturing enterprises to Internet enterprises. Internet power service platforms require more accurate meteorological data, such as the speed of data monitoring, sorting and transmission. The existing technical resources of enterprises are far from the technical level, which becomes the main boundary barrier to the construction of the Internet platform. Secondly, compared with the products of traditional industries, the products under the Internet platform have higher requirements for post-sales service. However, the operation and maintenance cost of the power industry is extremely high, which cannot be completed by one or two departments. Therefore, service barrier becomes another obstacle for enterprises to build a business ecosystem. Thirdly, the products of the Internet platform can be a variety of products under one industrial chain or different industrial chains. To build the Internet platform, the company needs to break through existing limits of resources to develop new products. In the electric power industry, product development and iterative upgrading costs are high, so what kind of product to choose for development is the third biggest boundary barrier for enterprises. Data support for the formation of key obstacles is shown in Table 2.

Table 2. The formation of critical obstacles.

Key Obstacles	Data Support
Outdated Technology	“Our power forecast between eight and ten o’clock in every morning, and I want to generate power forecasts from 1400 manufacturers. After the completion of production, it will be sent to the power grid company no later than 10 o’clock at the latest, the results will be summarized to the National power grid to form a dispatch. The whole data transfer is quite complex, such as the format of the file and the accuracy of the data fetching. There’s one part of the process that goes wrong and the whole forecast goes wrong”.
Single Product	“At the beginning of its establishment, the company only had the business content of wind power product prediction. It is a very typical manufacturing enterprise. But the power industry is inherently monopolistic, and without the support of other businesses, we can’t survive for very long”.
Service Responds Slowly	“In the early stages of business expansion, the biggest problem is staffing. The head office has good talent and technology, but the power plant is located in Inner Mongolia, and many employees are reluctant to go. If hire Inner Mongolia local maintenance workers, and cannot solve the problem of professional. We spent a lot of money to solve the problem of after-sales service”.

Therefore, in the process of building the business ecosystem of DR, boundary barriers of technology, service and product are encountered as Figure 2.

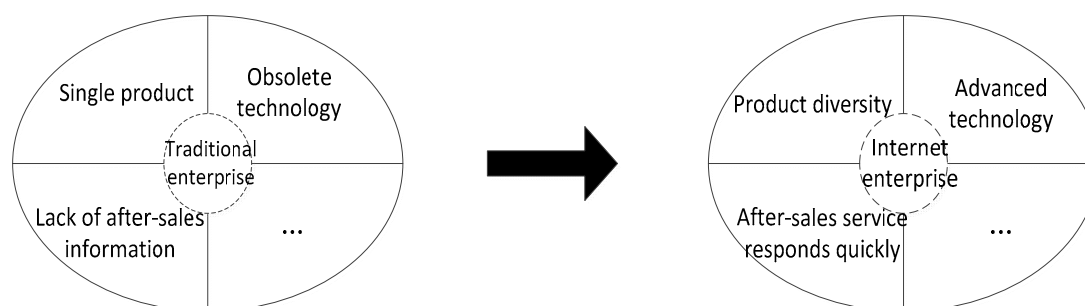


Figure 2. Major changes in old and new ecosystems.

4.3. Establish Boundary Spanning Model to Build a Sustainable Business Ecosystem

In the process of building a business ecosystem, enterprises need to choose appropriate ways to overcome the boundary barrier. From the boundary activities of DR, we find that there are various forces in the enterprise to solve the boundary obstacles. These forces produce a certain kind of regular behavior that we call “boundary spanning patterns.” These are composed of factors such as boundary spanner boundary spanning carrier and boundary spanning power. The formation of a boundary spanning mode not only contributes to the construction of business ecosystem, but also adapts business ecosystem to different market environments and generates sustainable competitive advantage.

In the stage of enterprise development, new products are the main focus of improving competitiveness. The mastery of core technology is the most critical step in the product development process. Therefore, R & D personnel with expertise in different technologies have become the main force for enterprises to overcoming technology boundary barriers, which we call boundary spanners [18]. Taking R & D personnel as boundary spanners can not only promote the development of new products and solve technical problems under different product categories, but also effectively graft, transplant and drive technological innovations to promote integration and development among industries [19] by, for example, recruiting new technical personnel and improving the technical level of the original R & D team, sending technicians to the institute to learn new technology, debugging and collecting data in the customer enterprise where the technical personnel are stationed. R & D personnel have become the main force in the process of enterprise boundary spanning, so that both the buyer and seller can accurately obtain their own needs and participate in the manufacturing process of products together. Finally, their roles have changed from operating system providers to Internet platform builders. Data support for the formation of key factors of boundary spanning is shown in the Table 3.

Table 3. The formation of key factors of boundary spanning.

Key Factors	Data Support
Border Spanner: Technician	“Technicians not only for the construction of the power generation system, but also for its operation, development and pricing. At the same time, it has to cooperate with financial institutions and other enterprises. Through continuous polishing of a single product, the channel of each link in the industrial chain is gradually opened, such as meteorological Bureau, Institute of Electrical Science, Institute of Atmospheric Physics, etc.”
Boundary spanning carrier: Project organization form	“Our company has 13 product lines, and a project team is responsible for each product line. Project team members are drawn from the staff pool when the project is approved, so they can be more flexible to support the newly developed products”
Boundary-spanning Incentives: Strategic Incentives	“As for the transformation direction and future development of our enterprise, leaders will constantly encourage everyone in every regular meeting, and there is also a tendency in the bonus part.”

With the accumulation and development of technical resources, enterprises achieve product diversification starting from the needs of users and the market. Clear boundaries between organizations make it difficult for enterprises to meet customers’ changing needs in time. Particularly, in the organizational structure of traditional enterprises, there are organizational boundary problems

such as information communication barriers, resource integration barriers and target coordination barriers in the cooperation and communication between departments [20]. Therefore, enterprises need to establish an organizational form aiming at responding quickly to customer needs to overcome existing organizational boundary problems. In this context, project responsibility system emerges, which becomes the boundary spanning carrier of enterprise. The organization form of project has broken the original business department and become a project team focusing on the development of a single product. It is composed of personnel from sales, marketing, R & D and other departments. It is flexible and compatible with various departments of the company. For example, after the approval of a new product, the personnel department will select appropriate sales, marketing and R & D personnel and form a team. In the process of new product development, team members conduct internal communication, learning, and discussions, etc., and adjust products, shorten the physical distance within the organization and improve communication efficiency. At the same time, the project team is also compatible with the existing organization of the company to obtain relevant organizational resources [21]. In short, the project team as the carrier of boundary spanning inspires the potential of boundary, changes the combination form between boundaries, and surpasses the barriers of organizational boundaries.

Compared with the boundary spanners and the boundary spanning carrier, how to make them an active linkage is a difficult problem in the boundary spanning activities of enterprises. We refer to the factors that promote the connection between the boundary spanner and the boundary spanning carrier as the boundary spanning dynamics. In the process of boundary spanning in DR, senior managers motivate employees' cross-border behaviors by means of strategic incentives, promote the connection between boundary spanner and the boundary spanning carrier to promote the construction of boundary spanning mode.

In the stage of resource accumulation, senior managers encourage employees to actively learn and communicate new technologies by formulating the direction of boundary spanning transformation and focusing on the development of new technologies. The company's early profits came from electric power products and lacked the business knowledge needed for the development of a wind power forecasting system. Therefore, the company sends technicians to relevant scientific research institutions to study and share with R & D personnel, providing a channel for the boundary spanner to learn and share. The introduction of new technologies from the top management of the company provides conditions and development space for the generation of boundary spanning technology resources. In the stage of business exploration, senior managers set up a project team to form a whole of those who cross the boundary. The common organization can promote the efficiency of internal information sharing and communication within the enterprise, and urge individuals to adjust their behaviors to adapt to the behaviors and needs of others [22]. Through regular technical exchange and irregular business communication, the company enhances the importance of operation and maintenance affairs within the company, and actively coordinates and supports the newly established business departments. During the establishment period of the platform, the company has formulated the general policy of transforming from a traditional enterprise to an Internet enterprise, so that employees can feel the transformation of the company's development strategy, change their behaviors to support the establishment of the platform, and have clear common cognition that enables individuals to execute cross-organization coordination more effectively. Boundary spanning mode structure are shown in Figure 3 below.

In conclusion, we can see that boundary spanner, carrier and dynamic force are the essential elements of the boundary spanning mode. The boundary spanner is the subject, acting on the object to be crossed with the help of the boundary spanning carrier, and the boundary spanning power not only promotes the linkage between the subject and the carrier, but also pushes the whole boundary spanning mode forward.

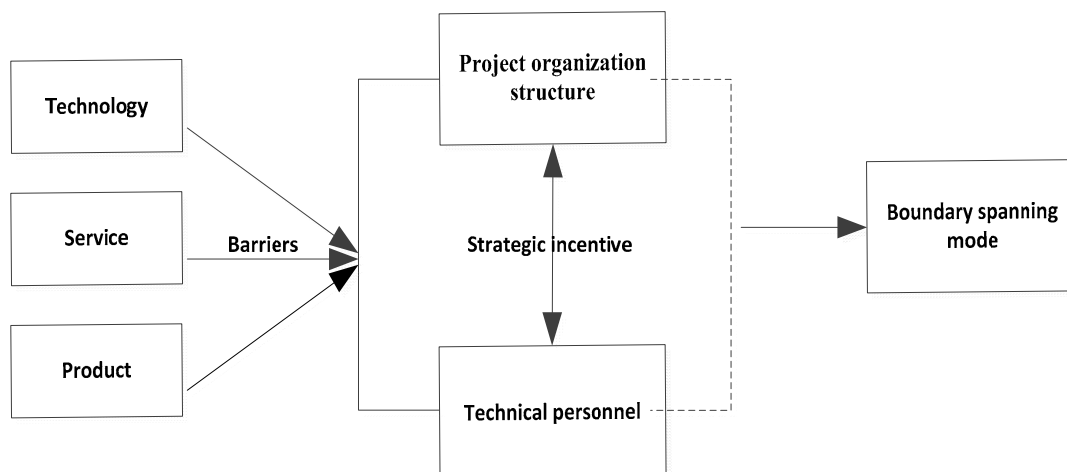


Figure 3. Boundary spanning mode structure.

4.4. The Formation of Management Capacity Promotes the Sustainable Development of Business Ecosystem

The boundary of an enterprise is essentially a problem of resource allocation. A good boundary management ability can enable an enterprise to effectively allocate resources to meet the needs of consumers [23,24]. Due to the existence of a specialized division of labor, enterprises cannot acquire all the capabilities. Even if they can have all the capabilities, it is difficult to have a comparative advantage in the capabilities. In the context of the rapid development of the Internet, enterprises need to be more compatible with boundary resources, technologies and organizations, so as to develop core technologies and thus improve their competitiveness. Therefore, the management ability of boundary resources plays an important role in promoting the development of enterprise business ecosystems and even controlling existing business ecosystem. In the boundary spanning activities of DR, the integration ability of boundary resources supports the operation of boundary spanning mode and promotes the development of its business ecosystem.

The ability of boundary integration lies in the integration of technology. The case enterprise integrates the experienced experts in the industry and combines the knowledge of different levels, contents and structures in the industrial chain to realize the upgrade of industrial technology. For example, sending technical staff to track projects in the Institute of Atmospheric Physics for the long-term acquisition of algorithms and modeling technology, so as to realize the system upgrade and vulnerability supplement of the predictive products within the company; creatively relating investment and consulting to the main business of the company, such as with grid-connected forecast products, which realize the long tail development of the core business, increase the high value-added part of the industrial chain [23], and create core competitiveness. Furthermore, the ability of boundary integration is embodied in the integration of organizations. The new energy enterprise in the Internet environment is a carrier of solutions that can meet the needs of customers. It faces a multi-dimensional product market. DR can transform from a single product provider to an Internet platform enterprise providing a variety of products and services, and has done a lot of integration activities on the organizational boundary. Data support for the formation of key ability of boundary spanning is shown in the Table 4.

Table 4. The formation of key ability of boundary spanning.

Key Ability	Data Support
Boundary Integration Capability	Good boundary management ability enables enterprises to effectively allocate resources to better meet the needs of consumers. In the context of the rapid development of the Internet, enterprises need to have ability to integrate boundary resources, technologies, organizations, etc., to ensure they can widely acquire external resources to develop core technologies and thus improve their competitiveness.
Key Action	Data Support
Technology Integration	“Our power forecast between eight and ten o’clock in every morning, and I need to generate power forecasts from 1400 manufacturers. After the completion of production, it will be sent to the power grid company no later than 10 o’clock at the latest, and then the results will be summarized to the National power grid to form a dispatch.”
Organizational Structure Integration	“Our company has seven product lines, but in the management level, the operations and human resources departments are combined. Instead of assigning R & D personnel to different departments according to product lines, the company unified them in the “R & D pool” and called them as needed in the demonstration process of new product lines. In this way, on the one hand, the waste of talents was avoided, and on the other hand, the communication between different product lines was strengthened. It also facilitates the management of talents”
Integration of Ecological Members	“Technicians not only for the construction of the power generation system, but also for its operation, development and pricing. At the same time, it has to cooperate with financial institutions and other enterprises. Through continuous polishing of a single product, the channel of each link in the industrial chain is gradually opened, such as meteorological Bureau, Institute of Electrical Science, Institute of Atmospheric Physics, etc.”

First of all, by recruiting high-level talents, participating in professional training organized by the industry, employing enterprises/external institutions to provide professional training and visiting learning between enterprises to supplement the knowledge bottleneck, organizing inter-company companies to learn the introduction of Huawei’s integrated product development process, and integrating all relevant departments based on customer needs. Secondly, the weekly morning meeting strengthened the coordination and communication among departments. The quarterly inquiry meeting timely reflected on the business status of the enterprise, and revised the future planning. This breaks the shackles of the traditional hierarchy or job position, effectively integrates and transfers resources, and reduces the physical distance within the organization [24]. Finally, the ability of boundary integration is embodied in the integration of ecological members. Product innovation requires more and more integrated technologies and categories, and customers have higher requirements of products. Therefore, product innovation not only relies on the strength of the new enterprise itself, but also requires the participation of many other members of the ecosystem [25]. Industry resources such as information exchange and resource integration with suppliers cannot only be conducive to product improvement and new product development, but also access to key technical information; communication with dealers can make reasonable improvements to products from the perspective of customers [26,27]. DR integrates the three resources of buyer (each power grid), seller (roof owner) and organized suppliers, and at the same time packages intermediary links such as financial services, after-sales operation and maintenance, and roof filing, which not only saves the previous high intermediary costs, but also enables all ecological members to form a benign and mutually beneficial state [28,29].

From the above analysis, we find that enterprise management ability is an important part of promoting enterprise development. In this case, boundary integration capability supports the operation of boundary spanning mode and promotes the sustainable development of enterprise business ecosystems [30,31]. Boundary spanning patterns and capability adaptations are shown in Figure 4 below.

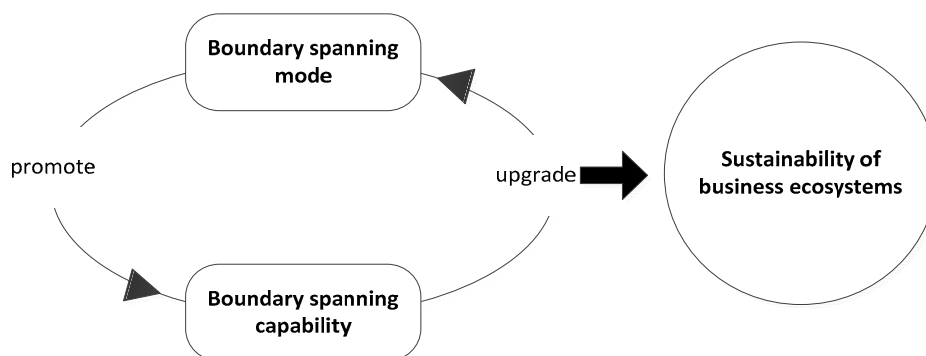


Figure 4. Sustainable relationships between boundaries and business ecosystems.

5. Conclusions

5.1. Research Conclusion

By looking for boundary barriers and establishing boundary spanning model to solve boundary problems faced by the business ecosystem, DR successfully constructed the new energy Internet platform “Energy Rubik’s Cube”, realized the visualization of meteorological data, and the value evaluation of investors on the new energy project line; helped the industry save time and cost in the initial evaluation stage by moving from offline field investigation to online inquiry; enhanced the company’s capabilities in weather data services; and increased the exposure of the platform by generating online queries traffic. “Energy Cube” is an Internet product developed under the tide of the Internet based on traditional business. It uses data mining technology to provide a service platform for governments, investors, enterprises and other industry participants. Today, dozens of cities have signed up for the Rubik’s Cube, which has spun off from the company as an Internet company that links the entire energy ecosystem with resources.

This paper opens the “black box” of business ecosystem sustainability in three steps: discovering boundary barriers, building a dynamic model, and forming capabilities.

Firstly, the identification of enterprise boundary barriers is the starting point. In the Internet environment, the three boundary barriers faced by electric power enterprises, such as technology, products and services, reduce production efficiency and affect the sustainable stability of enterprises’ competitive advantages. Such enterprises need to cross the boundary barrier, integrate industrial resources, make the business of different industries become related, break through the limitation of the traditional industrial chain, and thus constantly optimize and develop the business ecosystem.

Secondly, this paper found that the dynamic boundary spanning model is as the main body as a carrier for border spanner, technical personnel. At the same time, a certain degree of dynamic model, which is formed by the strategic incentive can fundamentally solve the problem of enterprises build commercial ecological system, the dynamic model from increased product line from within the validity of the internal and external communication, on the other hand will be related to the core product from outside the enterprise closely linked.

Finally, this paper finds that the formation of enterprise capacity can be matched with the dynamic pattern, which is more advantageous to promote the sustainable development of business ecology, that is, the integration ability of boundary resources. This capability is, on the one hand, the integration of core technologies and on the other hand the compatibility of organizational relationships between existing and new ecological members of the business ecosystem. The integration ability of boundary resources can enable the dynamic model to optimize continuously and promote the sustainable development of the business ecosystem. The formation mechanism of business ecosystem sustainability are shown in Figure 5 below.

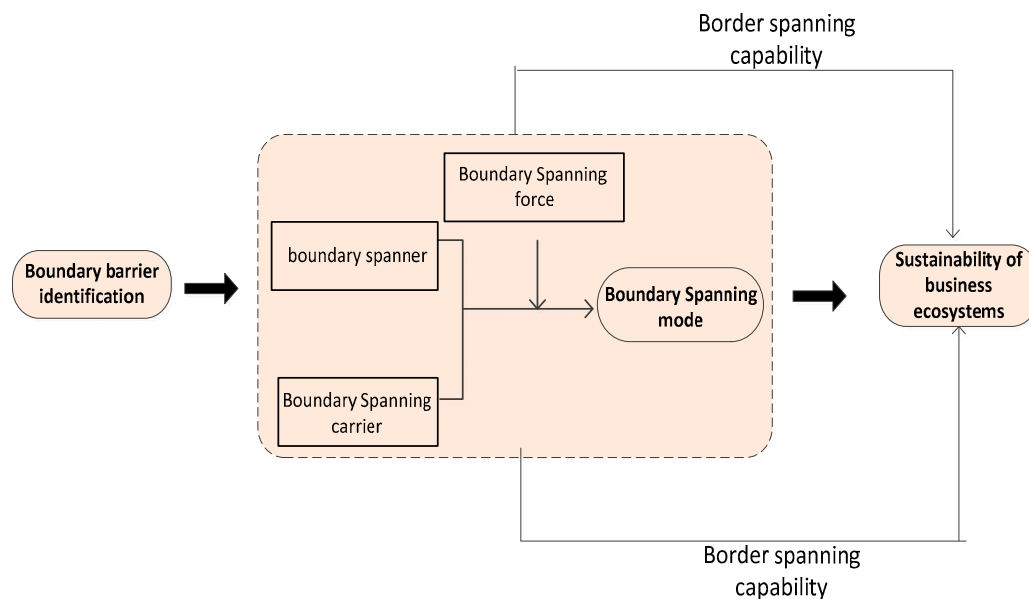


Figure 5. The formation mechanism of business ecosystem sustainability.

5.2. Theoretical Significance

Based on the boundary theory, this paper discusses the sustainability of business ecosystem. The conclusion of the study is not only of great theoretical significance, but also of great practical significance. The details are as follows:

Firstly, it identifies the major boundary barriers existing in the process of sustainable development of the business ecosystem. From the perspective of boundary, the current research mainly focuses on two aspects: the first is the division of boundary types; the second is the definition of boundary scope [32–34]. However, the focus of the study is static, which cannot meet the dynamic changes of the business ecosystem in the context of the Internet. In the context of Internet, enterprises encounter more diverse and flexible boundary barriers in the development and construction of the business ecosystem. It is not limited to the existing boundary type and scope definition. Therefore, through the analysis of the case enterprises, this paper re-identifies the boundary barriers, making full preparations for the subsequent enterprises to improve the business ecosystem through boundary crossing activities, and highlighting the contribution of this study in the field of practice and academia.

Secondly, this paper extracts the appropriate boundary spanning mode, which enriches the theoretical basis of boundary spanning. The existing literature on the research of boundary spanning activities is more about the concept, type and structure of boundary spanning, and the activity scope of boundary spanning is mostly the behavior within enterprises or between enterprises [35]. However, as the importance of the Internet scenario for enterprise business activities becomes more and more prominent, the boundary of enterprises presents dynamic and network-type changes [36], which brings about new boundary barriers. Based on different boundary barriers and considering the dynamic nature of boundary spanning, this paper extracts the boundary spanning patterns under different barriers. The boundary spanning mode contains three key factors; namely, the boundary spanning person, the boundary spanning carrier, and the boundary spanning power. The three internal factors not only have different connotations, but also have different main functions. They are indispensable small subjects in the boundary spanning mode [37–39]. Therefore, we can find that the key factor in the Internet situation border crossing pattern, great changes have taken place, through the internal dynamic adaptation, had formed the border crossing pattern of the main body, fill in the simple generalization problems in the theory of boundary spanning, at the same time, also for the enterprise in the border crossing activities provides a reference sample.

Thirdly, the capability of boundary management can promote the sustainable development of enterprise business ecosystem and enrich the theory of business ecosystem from the perspective of boundary spanning. The existing literature is very detailed on the study of business ecosystem, but there is still a lack of theoretical research on business ecosystem from the perspective of boundary spanning [40–42]. Moreover, there is little research on how boundary spanning activities can promote the sustainable development of the business ecosystem [43]. In the process of studying the boundary spanning mode, this paper finds that the new boundary management ability can support the development of the boundary spanning mode, thus playing an important role in the development of the enterprise business ecosystem.

Finally, to achieve long-term sustainable development, modern enterprises need to strengthen their own capabilities, more importantly, they need to be supported by a flexible and stable business ecosystem. Business ecosystem construction has different resource, environment, and technology constraints; enterprises need to confirm their boundaries, so as to build a sustainable competitive advantage of business ecosystem. At the same time, the enterprise should not focus on the individual itself, but take the overall situation into consideration to understand the health status of the entire ecosystem. It should not only protect its own survival and development, but also promote the health and stability of the system, so that the enterprise and the business ecosystem it is in can achieve sustainable development.

5.3. Limitations

This paper studies the boundary spanning behavior in the transition from traditional enterprises to Internet enterprises, and draws several conclusions with theoretical and practical value, but there are also some deficiencies. The DR enterprise is a traditional manufacturing enterprise at the beginning of its development. Influenced by the state monopoly power, it has particularity in industry and resources, which makes the boundary barrier it faces different from that of other enterprises. In future studies, we will further collect and interview other cases from different perspectives to promote the effectiveness of the sustainable development of business ecosystems.

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